Journal of Research in Business, Economics and Management (JRBEM)
ISSN: 2395-2210

SCITECH
RESEARCH ORGANISATION

Volume 10, Issue 3
March 31, 2018

Journal of Research in Business, Economics and Management
www.scitecresearch.com

Assessing the Energy Security in Russia: The AHP Approach

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Abstract

This paper develops a novel framework to assess the energy security (ES) of Russia. The framework is a mathematical model based on synergy of several researches in this field. First part of this research is literature review. Among 23 papers, 2 were selected as they had a good criteria classification system, combination of them was proofed to be the best for further framework development. Then, criteria weighting was conducted, using analytic hierarchy process (AHP), based on Russian legislative acts and risk analysis, provided by Russian authorities in "energy strategy 2035" normative act. As criteria were weighted, quantitative comparison became possible between reviewed papers. Comparison was conducted in 2 steps, first part is a brief comparison, based on amount of indexes and their comprehensively. Second part included AHP, conducted based on weights from previous step, and ratios of index dimensions. As a result of AHP, 3 approaches were selected as equally satisfactory for evaluating Russian ES. To select the best one, data restrictions analysis was conducted. Thus, one approach was selected as a base for framework to assess ES for case of Russia. However, it needed to be formalized as it offered only qualitative assessment for part of indexes proposed. This task was successfully solved in this paper.

Keywords: Energy Security; Russia; Analytic Hierarchy Process.

1. Introduction

Energy security (ES) is an important issue for many countries, as a big part of national security. Reasons countries are beginning to concern about energy security vary, depend on kinds of threats this country meets. Contrary to the focus on the events of the last four years (2014–2018) associated with the accession of Crimea to Russia and military conflict in Eastern Ukraine, serious changes in Russian domestic and foreign policy appeared. The concept of long-term economic and social development of the Russian Federation was developed at 2011. Against the background of a rapidly changing world development brings not only certain benefits, but in accordance with the dialectic of the development, a variety of new threats. Since political and economic conditions changed, assessment of ES for Russia has become a paramount issue. Last normative act in field of energy named "energy strategy 2035" was last updated at the end of 2014[24]. It emphasizes the importance of qualitative improvements of Russian energy sector infrastructure. It includes four strategic benchmarks: ES, energy efficiency, economic efficiency and sustainable development. Among the rest, document includes the list of target indicators for each section and wide recommendations for future development. Among these recommendations, designing a method of monitoring the state of the ES of the country. To design efficient ES assessment framework, it's necessary to analyze existing achievements in the field. Then, define the requirements to model, and select or modify existing approach, or connect several approaches together. Some approaches existing, are complicated and have too many parameters. This research proposes to choose easy accessible input data, to avoid unnecessary complicity.

2. Review of the literature

Various scientists and organization proposed approaches to evaluate ES. The results of literature review for articles found on science direct are provided in table 1. They show the author name, publication year, overall amount of indexes used, and amount of groups (dimensions), this indexes can be subdivided. Amount of dimensions shows how wide is field of study. Some researches propose to evaluate ES with no indexes, they propose a review, which can be used for qualitative assessment. Models, proposed in these researches, can be used to assess energy security. The next step is to form a criteria list for Russian ES assessment model.

Table 1: List of Reviewed Approaches

Ref.№	Approach author	Approach description	Dimensions	Amount of indexes	Main concern
1	**Månsson et al 2014**	**Commonly used methodologies**	**5**	**13**	**Complex**
2	Ang et al 2014	7 dimensions explanations	7	review	Classification
3	**Kumar et al 2013**	**AESPI - aggregated ES performance indicator**	**1**	**25**	**Complex**
4	**World energy council 2016**	**Energy Trilemma index**	**4**	**35**	**Complex**
5	**Kryut 2009/Ren, Sovacool 2014**	**4A meaningful**	**4**	**24**	**Classification**
6	Radovanović et al 2017	Sustainable approach	1	6	Complex
7	**Kisel et al 2016**	**ES matrix**	**6**	**27**	**Complex**
8	Bohringer and Bortolamedi 2015	Indicator nonsense	review	review	Critic
9	Kruyt et al 2009	4A approach original	4	review	Classification
10	Trainer 2017	Australia ES	review	review	Renewables
11	Konstantinos et al 2017	Ireland ES	1	2	Dependency
12	Kitamura and Managi 2017	Japan ES	undefined	18	Disruptions
13	Juozas et al 2017	Lithuania ES	undefined	68	Long term ES
14	Lochner et al 2011	Natural gas disruptions EU RU	1	graphs	Disruptions
15	Vivoda 2012	Fukushima Japan ES	review	review	Disruptions
16	Andreas et al 2010	Indicators of ES in industrialized countries	2	6	ES of supply
17	Le Coq et al 2009	EU ES	3	3	ES of supply
18	Gupta 2008	Oil vulnerability	3	7	ES of supply
19	Jansen and Seebregts 2010	Demand side ES	1	4	ES of supply
20	Ritcher and Holz 2015	Natural gas disruptions EU RU	review	graphs	Disruptions

21	Flouri et al 2015	Natural gas disruptions EU RU	5	simulation Monte Carlo	Disruptions
22	Mitrova et al 2016	Natural gas disruptions EU RU	review	Modelling	Disruptions
23	Maaike et al 2017	Natural gas disruptions EU RU	1	1	Disruptions

Selection of approach should be done, according to selection criteria. To compare them, one possible way is also to use AHP(analytic hierarchy process). However, amount of reviewed papers is too big to use this method. Thus, at first place, the Pareto principle 30-70 can be used to choose 30% of best approaches. Amount of indexes should belong to middle 50% of percentile in index amount distribution, as it was shown in Ren/Sovacool's research [5], and should equally concern about all the dimensions reviewed. Also, they should be chronologically relevant, not older than 5 years. Only 5 approaches among reviewed satisfy all this requirements (**Bold** in table 1).

3. Methodology

3.1. Framework requirements

To select one of proposed methods as a framework to assess ES for case of Russia, it's necessary to understand, what's important for Russia at the first place. To formalize it, classification system should be selected. Among reviewed in 2.1 approaches, some can be used as classifiers. For purposes of research, commonly used for cases of different countries in scientific literature approach is 4A, proposed by Ren, Sovacool in 2014, but it only focuses on 4 dimensions, which is not too comprehensive. Research conducted by Ang et al (2014), proposes 7 dimensions, which is satisfactory as each index will have near 14% average weight with assumption of equal importance, but dimensions are not defined too clearly. Combination of Ang et al dimensions with 4A indexes may lead for more comprehensive approach (table 2).

Table 2: Commonly used Dimensions for ES Assessment

Energy Availability	Infrastructure	Energy Prices	Societal Effects	Environ ment	Governance	Energy Efficiency
Security of supply	Electrification	Price stability	Social satisfaction	Environ ment	National governance	Efficiency
Self-sufficiency	Decentralization	Dependency	Military power		International governance	Innovation
Diversification	Equity	Market liquidity			Transparency	Technological maturity
Renewable energy	Safety and reliability	Import, export stability			Political stability	
Technological maturity		Trade				
		Investment and employment				
		Exchange rate				

After dimensions are defined, next step is to find a weight of each dimension for more accurate assessment. Conduct such a weighting for context of the whole country is not an easy task. The main difficulty is to find a way to avoid subjectivity, and provide enough scientific proof to make acquired data relevant. One way is to make pairwise comparison of dimensions, using hierarchy analysis method, arguing whether one of them has more threats than other. The detailed risk analysis of Russian energy sector was conducted by Russian government in the end of

2014, while developing the "Russian strategy 2035" normative act, which is updated yearly. Analysis of that document, allows to make a pairwise comparison of each definition. To avoid further subjectivity, hierarchy analysis method was applied 3 times, by author and author's colleagues independently, after reading and analyzing that document, based on threats sources and their importance for Russian economy. The results (table 3a), acquired by each group member were statistically compared, derivation doesn't exceed 15,3 % 4A.dimension weights are calculated from table 3a data.

Table 3a. Ang Et Al's Approach Dimensions Weights; Table 3b. 4A Dimensions Weights

3a	**Ang et al**	**Energy availab.**	**Infrastr.**	**Energy prices**	**Societal effects**	**Envir.**	**Govern.**	**Energy efficiency**
	Weight	4%	33%	24%	5%	5%	10%	20%
3b	**4A**	**Availability**	**Affordability**	**Acceptability**	**Accessibility**			
	Weight	6.67%	40.00%	26.67%	26.67%			

3.2. Hierarchy method application

Based on amounts of indexes of each category (table 4), we can choose the best approach. First, for every approach, indexes are attached to one of dimensions in classification proposed in 2.2, then, overall amount of indexes in each dimension is calculated. With assumption all the indexes in selected approaches are equally important, subjectivity in method selection can be avoided.

Table 4. Amount Of Indexes In Different Definitions

Approach	Energy availability	Infrastructure	Energy prices	Societal effects	Environment	Governance	Energy efficiency
Månsson's approach	3	7	4	2	1	2	1
	15%	35%	20%	10%	5%	10%	5%
AESPI approach	18	11	1	1	2	1	2
	50%	31%	3%	3%	6%	3%	6%
Energy Trilemma approach	4	4	7	4	7	10	8
	9%	9%	16%	9%	16%	23%	18%
Meaningful 4A approach	5	4	6	2	1	4	3
	20%	16%	24%	8%	4%	16%	12%
ES matrix approach	7	3	2	3	1	5	1
	32%	14%	9%	14%	5%	23%	5%

After getting numbers of indexes in each dimension, we can apply second part of hierarchy method with data from table 4 to quantitatively evaluate acceptability of proposed approaches to evaluate ES for case of Russia (table 5).

Table 5. Defining the Best Approach to Use as a Framework for ES Assessment, Using AHP Method									
Approach author	**Approach Description**	**Energy avail.**	**Infr.**	**Energy prices**	**Soc. eff.**	**Envir.**	**Gover.**	**En.eff.**	**Weight**
Mannson et al 2014	Commonly used methodologies	15%	35%	20%	10%	5%	10%	5%	**24%**
Kumar et al 2013	Aggregated ES performance indicator	50%	31%	3%	3%	6%	3%	6%	**16%**
World energy council 2016	Energy Trilemma index	9%	9%	16%	9%	16%	23%	18%	**23%**
Kryut 2009/Ren, Sovacool 2014	4A meaningful	20%	16%	24%	8%	4%	16%	12%	**22%**
Kisel et al 2016	ES matrix	32%	14%	9%	14%	5%	23%	5%	**16%**

Result shows that 3 approaches are equally good to assess ES of Russia: Energy Trilemma index, Meaningful 4A and commonly used methodologies description. Approaches by Kumar and Kisel focus too much on availability, so they won't be used in further research .As 3 approaches are almost equally good to evaluate ES of Russia, the best choice depends on data availability.

3.3. Data Restriction Analysis

Before in this research, indicators in each approach haven't been reviewed from the side of data availability, but just application field. Now, when 3 approaches are defined to be suitable, the main issue is data availability for index computation.

3.3.1. Månsson's Approach Data Availability Restrictions Analysis

The approach to assess ES, proposed by Månsson, has 5 dimensions and 13 indexes, however, only 4 indexes can be computed based on easy accessible data, others require additional research, which makes application of this method hard(table 6). This approach can be useful when main agenda is economic analysis, because all the dimensions have a connections with economics.

Table 6. Månsson's Approach Data Availability		
Dimension	**Indicator**	**Data**
Supply of primary energy	Availability of primary resources	Yes
	Geographical concentration of resources	Yes
	Forecasts or scenarios of energy export	Yes
	Average production cost fluctuations	Yes
Upstream markets and imports	Systematic and specific risk	No
	Reliability of suppliers and supply routes	No
	Dependence, independence or interdependence among states	No
Domestic markets and infrastructure	Reliability, resilience and robustness of infrastructure	No
Economic vulnerability	Welfare loss from high or volatile prices	No
	Economic consequences of resource scarcity	No
	Outage cost from power disruptions	No

Integrated methods	Holistic supply chain security/ security of energy services	No
	Spatial and/ or temporal comparisons of security	No

3.3.2. Meaningful 4A Approach Data Availability Restrictions Analysis

The 4A approach to assess ES, has 4 dimensions and 24 indexes and has the best data availability (Table7). All the indexes may be calculated without additional research, or found on statistical resources. Thus, this a good option to use as a framework for Russian ES assessment.

Table 7. Meaningful 4A Approach Data Availability

Dimension	Index	Data availability
Availability	Security of supply	Yes
	Self-sufficiency	Yes
	Diversification	Yes
	Renewable energy	Yes
	Technological maturity	Yes
Affordability	Price stability	Yes
	Dependency	Yes
	Market liquidity	Yes
	Decentralization	Yes
	Electrification	Yes
	Equity	Yes
Acceptability	Environment	Yes
	Social satisfaction	Yes
	National governance	Yes
	International governance	Yes
	Transparency	Yes
	Efficiency	Yes
	Innovation	Yes
	Investment and employment	Yes
Accessibility	Import stability	Yes
	Trade stability	Yes
	Political stability	Yes
	Military power	Yes
	Safety and reliability	Yes

3.3.3. Trilemma Approach Data Availability Restrictions Analysis

The energy trilemma approach to assess ES, has 4 dimensions and 35 indexes, but to calculate some of indexes, several subindexes are to be computed. Some of them require specific data. In total, trilemma approach has 88 input variables. It's necessary to make some simplification in order to ease application, or choose different approach. Big amount of subindexes mitigates an importance of each index. In such a case, evaluation should be conducted very precisely, which requires a big amount of data. In this research it's recommended to choose different approach. However, this approach is good to assess the long-term ES.

3.4. Mathematical Model

According to analysis, conducted in chapter 3.3, the best approach to use for ES evaluation for Russia case is 4A meaningful approach. It has adequate amount of indicators: 24, which satisfies an interval of [10-25] indexes proposed by Ang et al, 2014. Too much indexes can underestimate the importance of particular indexes. Too small amount can lead to overestimation of each index. Data for the proposed indexes can be found and are available on Russian ministry of energy statistical resources and in results of 2010's population census, unlike for Energy Trilemma approach. Mansson's approach's dimensions are defined too fuzzy and hard to be interpreted into mathematical equations, what makes this approach unacceptable for further modelling. Result of research, conducted in previous chapters shown that the rational way to assess energy security for case of Russia is the 4A approach, proposed by Ren and Sovacool in 2014. This approach includes 4 dimensions and 24 indexes, and been reviewed in chapter 3. Approach is good to assess the short-term ES. Each index provides information about one of aspects of Russian energy sector, part of them are calculated, and part are taken as they are. The most meaningful assessment related to dimensions, as it can help to define priorities for decision making unit. To apply this approach, it's necessary to find values of indexes in borders [0;1], then, find arithmetic average value for each dimension, and in the end, find total average, which will be a composite ES index. Assessing is short term, for given year. Part of indexes is taken from the Global Economy is a recommended online resources by the American Economic Association.[25] Part of indexes is proposed by 4A approach authors[5]

1. Security of supply (A11)

$$A11 = \frac{TPES}{TPEC} \tag{1}$$

Where:

TPES – total primary energy supply

TPEC – total primary energy consumption

2. Self-sufficiency(A12)

$$A12 = \frac{M}{TPEC} \tag{2'}$$

Where:

M – Import of energy, kWh

For this indicator, less value means better ES, and it changes in borders [0;1]. To use it in further equations, it's reasonable to subtract A12 from one (4.3 equation), so bigger value of index means better ES. If M>TPEC, index should be equal to zero, negative values will not reflect self- sufficiency depreciation, but management low efficiency.

$$A'12 = 1 - \frac{M}{TPEC} \tag{2}$$

3. Diversification(A13)

$$A13 = HHI = S_{fossil}^2 + S_{renewables}^2 + S_{nuclear}^2 + S_{others}^2 \tag{3}$$

Where: S_i– Share of resource i in total supply

4. Renewable energy(A14)

$$A14 = \frac{\text{renewables installed capacity}}{\text{total installed capacity}} \tag{4}$$

5. Technological maturity(A15)

Russian energy sector is a global system. The evaluation of technological maturity can be conducted according to "ISO 15504: Information technology – process assessment" standard, which propose to use 5 levels of technological maturity. Technological maturity can be defined as a mean of process attributes. Expert assessment.

$$A15 = \frac{\sum_{p=1}^{9} ATT_p}{9} \tag{5}$$

6. Price stability(A21)

Defined as a derivation from trend mean for given year. Calculated for oil and gas. Statistics are taken for 15 years. Calculations conducted in MS excel. (LINEST function). To normalise indicator, deviation is calculated in amount of sigma, and probability function for this deviation will be inversely proportional to ES index value.

$$A21 = 1 - \mathrm{NORM.DIST}\left(\frac{\text{fact price} - \text{trend mean price}}{\text{STDEV(price fol last 15 years)}}\right) \quad (6)$$

7. Dependency(A22)

$$A22 = 1 - \frac{M}{\text{population}} \quad (7)$$

8. Market liquidity(A23)

Qualitative parameter. Can be assessed on a five-point rating scale from very low to very high with a step of 0.25. For case of Russia, liquidity of gas, coal and oil are paramount issues. Expert assessment.

$$A23 = (Lgas + Loil + Lcoal)/3 \quad (8)$$

Where:

Li–liquidity of the resource i

9. Decentralisation(A24)

$$A24 = \%\text{smallscale electric nets}/\text{TPES} \quad (9)$$

10. Electrification(A25)

$$A25 = \%\text{population have access grid} \quad (10)$$

11. Equity(A26)

$$A26 = 1 - \%\text{ households on wood} \quad (11)$$

12. Environment(A31)

Consist of 2 sub-indexes: CO2 intensity for given year compare to historical max, and lumber harvesting index, showing tree grow/cut balance

$$A311 = \frac{CO2(\text{given})}{CO2(1990)} \quad (12)$$

$$A312 = \frac{\text{Tree grow area}}{\text{Tree cut area}} \quad (12.1)$$

$$A31 = \frac{A311 + A32}{2} \quad (12.2)$$

13. Social satisfaction(A32)

Satisfaction with Life Index can be taken from Satisfaction with Life Index Website [27].

14. National governance(A33)

National governance efficiency index can be taken from Global economy website. Index should be normalised, as on website, index is comparative and lies in borders between -2.5 and 2.5. [25]

$$A33 = \frac{NGE + 2.5}{5} \quad (13)$$

Where: NGE – National governance efficiency

15. International governance(A34)

International governance efficiency, correlates with country risk index, which can be taken from Global economy website. Index should be normalised, as on website, index is comparative and lies in borders between 0 and 7. [25]. Country risk index can be long and short – term. For purposes of research, mean can be taken.

$$A34 = \frac{\left(1 - \frac{CRI_{long}}{7}\right) * \left(1 - \frac{CRI_{short}}{7}\right)}{2} \quad (14)$$

Where:

CRI_{long} – country risk index, long - term

CRI_{short}– country risk index, short- term

16. Transparency (A35)

Correlates with corruption index. Index can be taken from Global economy website. Index should be normalised, as on website, index is comparative and lies in borders between 0 and 100. [25]

$$A35 = \frac{CI}{100} \quad (15)$$

Where:

CI – Corruption Perceptions Index

17. Efficiency (A36)

$$A36 = \frac{\text{Energy loss}}{\text{TPES}} \quad (16)$$

Determines the efficiency of power sector. Computed as a relation of unused (lost) energy to total produced energy. The output normalised value of security is equal to 1-A36.

18. Innovation index (A37)

Innovation index can be taken from Global economy website [25]. Index should be normalised, as on website, index is comparative and lies in borders between 0 and 100.

$$A37 = \frac{II}{100} \quad (17)$$

Where: II –innovation index

19. Investment and employment (A38)

Qualitative parameter. Can be assessed on a five-point rating scale from very low to very high with a step of 0.25.Expert assessment.

20. Import stability (A41)

Qualitative parameter. Can be assessed on a five-point rating scale from very low to very high with a step of 0.25.Expert assessment.

21. Trade stability (A42)

Qualitative parameter. Can be assessed on a five-point rating scale from very low to very high with a step of 0.25.Expert assessment.

22. Political stability (A43)

Political stability index can be taken from Global economy website [25]. Index should be normalised, as on website, index is comparative and lies in borders between -2.5 and 2.5.

$$A43 = \frac{PSI + 2.5}{5} \quad (18)$$

Where:

PSI – political stability index

23. Military power (A44)

Index can be taken from official "Military Strength Ranking" website[26].

24. Safety and reliability (A45)

This index show the percentage of time grid was working within standardised deviation borders.

$$A45 = \%\ \text{stable work} \tag{19}$$

4. Data analysis

In chapter 3, framework to assess ES of Russia was described. To use it, it's necessary to define all the input variables (Table 8). The data sources for input variables are listed in chapter 3. Latest input data were available for year 2016. Some indexes are more accurate to calculate, taking an information for last several years.

Table 8. Input Variables to Assess ES of Russia

Input variables:	2016	2015	2014	2013
TPEC, grid, bill kWt*h	1026.65	1008.20	1013.24	
TPEC, total, bill kWt*h	1054.43	1036.40	1040.55	1009.80
TPES, grid, bill kWt*h	1048.26	1026.80	1024.75	
TPES, total, bill kWt*h	1071.29	1058.51	1056.80	1023.50
Pike power, MWt	151052.00	147377.00	154709.00	147046.00
Total installed power, MWt	236343.00	235305.00	232451.81	226470.00
M-X,bill kWt*h	-17.30			
Oil X, mln t	254.2	244.5	223.5	236.6
Oil X Dollar	86199.22	89587.8	153895.5	173668.3
Gas X, mln t	185.50	174.30	196.40	178.70
Gas X Dollar	41844.30	54685.10	65971.60	62253.30
Energy loss	0.0157	0.0209	0.0154	0.0134
Thermal power plants, % in TPES	58.6	59.8	60.6	60.8
Renewables %	17.00	15.60	16.30	17.10
Nuclear, % in TPES	18.7	15.6	17.6	16.8
Others, % in TPES	5.7	5.6	5.5	5.3
Urbanisation, 2010	74%			
Households, mln	54.6			
CO_2 intensity in 1990 In 2016	3862.507 2651			
	Index	**Normalized**	**Borders: from… to…**	
Forest cut/year	36.5	0.4438356		
Forest grow/year	16.2			
Political Stability	-1.05	0.29		
Innovation index	38.5	0.385		
Government efficiency	-0.18	0.464		
Pol risk long	4	0.4285714	0	7
Pol risk short	3	0.5714286	0	7
Corruption Perceptions Index	29	0.29		
Satisfaction index	143.33	0.2500289	273.3	100

5. Results

Applying a mathematical model from chapter 3, using input variables from chapter 4 (table 8), ES of Russia can be assessed (Table 9). ES assessed in 4 dimensions. Result can show the problems of Russian energy sector, and help to manage risks. Output result rounded to 2 decimals. All output variables are normalized from 0 to 1, and give an understanding of security in given field.

Table 9: ES assessment result for case of Russia

Approach			Norm. data	ES	NI
Availability	Security of supply	TPES/TPEC	1	78.4%	4.7%
	Self-sufficiency	M/TPEC	1		
	Diversification	HHI	0.58		
	Renewable energy	Renewables/TPES	0.83		
	Technological maturity	Qualitative	0.5		
Affordability	Price stability	Derivation from trend mean	0,76	74.3%	33.3%
	Dependency	M/Population	1		
	Market liquidity	Qualitative	0,75		
	Decentralization	%small-scale/TPES	0.973		
	Electrification	%population have grid	0.978		
	Equity	% households on wood	0,98		
Acceptability	Environment	CO_2 intensity (2016)	1	53.5%	40.0%
		Lumber harvesting	0.44		
	Social satisfaction	Satisfaction index	0.25		
	National governance	Government Efficiency	0.46		
	International governance	Country risk	0.5		
	Transparency	Corruption index	0.29		
	Efficiency	Loss/TPES	0.98		
	Innovation	Innovation index	0.38		
	Investment and employment	Qualitative	0.5		
Accessibility	Import stability	Qualitative	1	74.4%	22.1%
	Trade stability	Qualitative	0.5		
	Political stability	Political stability index	0.29		
	Military power	Mil power index	0.92		
	Safety and reliability	Uptime %	1		
MEAN ES				70.15%	

Normalized importance (NI) is a suggestion about which problem should be solved first. It is calculated from dimension weights of Ren/Sovacool (table 3b) and ES values, and then, normalized. ES Assessment can also be conducted in 7 dimensions, of Ang et al, proposed in table 3a.

6. Discussion

Developed framework allows us to assess ES of Russia in different dimensions, showing that current mean ES for case of Russia is rated at 70.15%. Acceptability threat, as it refers to the environmental and social consequences of energy production and use, appeared to be bigger problem than it could look from beginning. Questions of governance and social satisfaction hit hard on Russian ES. Transparency is low. Innovations are slowly implemented, technology and infrastructure aging is an important issue. Lumber harvesting rates are too high, and soon can also be a big problem. Even though Acceptability security is not high, its importance as a dimension, is less than Affordability, which makes overall security better. The biggest problems of Affordability, as a dimension which reflects state for energy prices for households and industries, are low fuel price stability and imperfect market liquidity. The question of oil and gas prices forming are pivotal for Russian economy. The main problem is a huge volatility of that market, what makes Russian economy significantly dependent on oil/gas market, due to big export volumes. Accessibility, as it emphasizes geopolitical and resilience aspects of national energy systems, also has vulnerabilities. Based on received data, main problems are trade stability and political stability, which correlates with affordability problems as well. Availability influenced by the energy resources and security of energy supply for a given country. For Russia is not a big threat, but some problems can be caused by not enough diversification of resource sources.

Reviewing the results of ES in four dimensions key recommendations for governance can be:

1) Develop power engineering (complex modernization of oil refining, Unified energy system, development of smart networks, decentralized generation, comprehensive modernization of heat supply, etc.);

2) Increase the efficiency of reproduction of reserves, extraction and processing of fuel and energy resources to meet domestic and external demand;

3) Increase availability (by price, availability and reliability) and the quality of energy products and services (through the introduction of technology standards, reducing the costs of energy companies, effective state regulation, infrastructure modernization);

4) Increase flexibility and diversification of export supplies (entering new markets and developing new export routes, as well as new export products);

5) Increase the competitiveness of Russian energy companies in foreign markets;

6) Limit the growth of internal wholesale prices.

Russian economy strongly relies on gas and oil export, gas and oil exporting strategies so customers diversity and transit security, energy saving technology development and internal energy infrastructure development are paramount questions.are the most important questions.

7. Conclusion

Each part of this research helps to accomplish a part of objectives, stated at abstract. The result of literature review is a comprehensive understanding of a progress in the field of energy security, and a list of researches, appropriate to use as a basis for ES assessment framework in future research. Second part of review pointed at strong and weak points of Russian energy sector, which is useful for AHP. Aggregating 2 ES assessment approaches allowed to get more comprehensive approach. For Russian economy, most important dimensions are: Infrastructure (33%), energy prices (24%). The result of AHP when using Saati scale, is always subjective. However, multiple application by expert group, and previously conducted analysis, can mitigate this subjectivity. Among 4A, most important for case of Russia is affordability, least threat is accessibility. Among 5 pre-selected from easy-accessible parameters approaches, 3 are almost equally good. In future research, other 2 may be used as well. Data restriction analysis had a target to choose the easiest way to assess ES of Russia. From this point, 4A approach is easiest to formalize and use. It has adequate amount of indicators: 24, which satisfies an interval of [10-25] indexes proposed by Ang et al, 2014. Too much indexes can underestimate the importance of particular indexes. Too small amount can lead to overestimation of each index. Data for the proposed indexes can be found and are available on Russian ministry of energy statistical resources and in results of 2010's population census, unlike for Energy Trilemma approach. Mansson's approach's dimensions are defined too fuzzy and hard to be interpreted into mathematical equations, what makes this approach unacceptable for further modelling. Based on 4A, by normalising each index in borders [0;1], we can build a mathematical model. To get dimension ES, we should find mean average, as not as sensitive to little system deviations as geometric mean, which would require very accurate input data. After defining framework, to use it, input data required. Chapter 3.4, describes framework, and gives sources for input data. All output variables are normalized from 0 to 1, and give an understanding of security in given field. Latest input data were available for year 2016. Some indexes are more accurate to calculate, taking an information for last several years. Defining all the input variables, resulting outputs are values of energy security in four dimensions and 24 indexes (chapter 5), which can help to understand ES situation in Russia, what is discussed in chapter 6.

To form a universal model to easily evaluate any country's ES is a task of scientific society, and each paper makes this target closer.

ACKNOWLEDGEMENT

I want to express gratitude to my supervisor, Professor Zhou Peng for flawless advisory work, and support during my study.

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